



NOTES ON SARCOPHAGINAE IN INDIA AND AUSTRALIA.

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[Read 27th May, 1936.]

In his Revision of the Sarcophaginae of the Oriental Region, Mr. R. Senior-White (1924) considered that five species of *Sarcophaga* reach the Australian Region. It has become evident that specific relationships as then understood by that author need modification, and the relationship is one of groups, not species. It is due to the courtesy of Mr. Senior-White that I have been able to compare his reference collection of mounted genitalia taken from Indian species, finding there relationships that were not detected through the illustrations that he has hitherto published. I feel very grateful for the loan of this collection, for it has permitted me to gain an insight into various structures that otherwise may have taken years to acquire.

The assessment of the relationship between Indian and Australian Sarcophagases.

Before me are 25 species of *Sarcophaga* from Australia, 37 from India and Ceylon, and 1 from the Philippines. Amongst these 27 alliances are found, and it is possible further alliances have been overlooked or even a few species misplaced in *Parasarcophaga*, for the Oriental material is represented by genitalia only, one example for each of the 37 species. Also these, being mounted on slides, sometimes have their parts obscured, and it is not easy to reconstruct various structures that may have been overlapped by others. Nevertheless, I have concluded that 57% of the Indian, and 28% Australian species belong to subgenus *Parasarcophaga*, whilst a further 13% Indian species fall in groups containing 32% Australian species. The remaining 30% Indian and 40% Australian species are without mutual affinities recognized at present. The list is as follows:

Subgenus PARASARCOPHAGA.	
(Australian.)	(Oriental.)
	<i>albiceps</i> -group.
<i>omega</i> J. & T., 1921; <i>gamma</i> J. & T., 1921.	<i>albiceps</i> Meigen, 1826; <i>knabi</i> Parker, 1917; <i>flavipalpis</i> S.-W., 1924; <i>hirtipes</i> Wied., 1830; <i>orchidea</i> Bott.
	<i>misera</i> -group.
<i>misera</i> Walker, 1849; <i>kohla</i> J. & H., 1923; <i>eta</i> J. & T., 1921.	<i>dux</i> Thomson, 1868; <i>harpax</i> Parker, 1897; <i>scopariformis</i> S.-W., 1927; <i>tsushima</i> S.-W., 1924.
	<i>peregrina</i> -group.
<i>peregrina</i> Desv., 1830.	<i>fuscicauda</i> Bott., 1912.
	Miscellaneous.
<i>aurifrons</i> Macq., 1846.	<i>aurifrons</i> Dol., 1856 (= <i>doleschalli</i> J. & T., 1921); <i>ballardi</i> S.-W., 1924; <i>khasiensis</i> S.-W.; <i>annandalei</i> S.-W., 1924; <i>kempi</i> S.-W., 1924; <i>walayari</i> S.-W., 1924; <i>caudagalli</i> Bott., 1912; <i>futuris</i> S.-W., 1924; <i>ostindicae</i> S.-W., 1924; <i>bambridgei</i> S.-W., 1925; <i>haemorrhoidalis</i> Meig., 1826.

	Subgenus SARCOPHAGA (with propleura bare). <i>ruficornis</i> -group.
<i>kappa</i> J. & T., 1921.	<i>ruficornis</i> Fab., 1794.
<i>cenia</i> J. & H., 1923.	<i>crinita</i> Parker, 1917.
	Subgenus ————— (with propleura hairy). <i>antilope</i> -group.
<i>alpha</i> J. & T., 1921; <i>zeta</i> J. & T., 1921; <i>beta</i> J. & T., 1921; <i>furcata</i> Hardy, 1932.	<i>antilope</i> Bott., 1913; <i>henryi</i> S.-W., 1924; <i>flavinervis</i> S.-W., 1924.
	<i>impatiens</i> -group.
<i>impatiens</i> Walker, 1849; <i>tryoni</i> J. & T., 1921.	<i>banksi</i> S.-W., 1924 (Philippines).
	Miscellaneous.
	(Propleura bare.)
<i>depressa</i> Desv., 1830; <i>bancrofti</i> J. & T., 1921; <i>spinifera</i> Hardy, 1932.	<i>melaneura</i> Meig., 1826; <i>gravelyi</i> S.-W., 1924; <i>pattoni</i> S.-W., 1924; <i>calcifera</i> Bott., 1912; <i>aspinata</i> S.-W., 1924;
	(Propleura hairy.)
<i>epsilon</i> J. & T., 1922; <i>omikron</i> J. & T., 1921; <i>hardyi</i> J. & T., 1922; ? <i>fergusoni</i> J. & T., 1922; <i>littoralis</i> J. & T., 1922; <i>froggatti</i> Taylor, 1917; <i>alcicornis</i> Hardy, 1932.	<i>haematodes</i> Meig., 1826; <i>falcata</i> v. <i>persicae</i> S.-W., 1924; <i>pusana</i> S.-W., 1924; <i>beesoni</i> S.-W., 1924; <i>talonata</i> S.-W., 1925; <i>orientalooides</i> S.-W., 1924.

As the propleural character of the Indian species is unrecorded, I am not able to group these under their respective subgenera, but I note that the posterior clasper has a subapical bristle on *pattoni*, *calcifera* and *talonata*, and a median bristle on *gravelyi* and *beesoni*. The others do not have any bristle apparent.

Key to genera of Australian Sarcophaginae.

1. First radial vein bristly. Propleura bare. Three postsutural dorsocentral bristles.
Posterior clasper with two bristles on the posterior half ?*Helicobia*
First radial vein bare 2
2. Three postsutural dorsocentral bristles. Propleura bare. Posterior clasper without
bristles ?*Blaesoxiphia*
Four postsutural dorsocentral bristles. Propleura with hairs, or bare. Posterior
clasper with bristles *Sarcophaga* Meig.

Key to species of Australian Sarcophaga.

1. Propleura with hairs in abundance Subgen. ———. 14
Propleura bare, or at most with a limited amount of black bristly hairs confined to
centre 2
2. Posterior clasper with a pair of closely adjacent, rarely widely separated, subapical
bristles Subgen. PARASARCOPHAGA. 3
Posterior clasper with bristles otherwise arranged Subgen. SARCOPHAGA. 9

Subgenus *Parasarcophaga*.

3. Propleura with a few black bristly hairs in centre *peregrina* Desv.
Propleura entirely bare 4
4. Anterior appendage in the form of a cup-shaped process arising from a stalk
..... *albiceps*-group. 5
Anterior appendage otherwise formed 6
5. Process of anterior appendage widely diverging *gamma* J. & T.
Anterior appendage compact, the process being short *omega* J. & T.
6. With one or more rows of black bristly hairs behind postoculars 7
Without such bristly black hairs *misera* Walk.
7. Anterior appendage with two pairs of foliaceous parts *kohla* J. & H.
Anterior appendage with only one pair of foliaceous parts 8
8. Anterior appendage excessively long, projecting considerably beyond apex of sheath
..... *eta* J. & T.
Anterior appendage normal in length, about as long as sheath *aurifrons* Macq.

Subgenus *Sarcophaga*.

9. With three bristles spaced wide apart on posterior clasper	10
With only one bristle on posterior clasper	11
10. Genital segment red	<i>securifera</i> Vill.
Genital segment black	<i>kappa</i> J. & H.
11. Antennae red	<i>bancrofti</i> J. & T.
Antennae black	12
12. Bristle on posterior clasper placed subapically	<i>depressa</i> Desv.
Bristle on posterior clasper placed basally	13
13. With two rows of black bristly hairs behind postoculars	<i>synia</i> Hardy
With one row of black bristly hairs behind postoculars	<i>spinifera</i> Hardy

Subgenus —————.

14. With bristle on posterior clasper placed from the median to the subapical position	15
With the bristle on the posterior clasper placed basally	26
15. Anterior clasper bifid	<i>antilope</i> -group. 16
Anterior clasper often with a large flange but not bifid	20
16. Cleft of anterior clasper reaching base; apex of sheath at most bifid	17
Cleft of anterior clasper not reaching base; apex of sheath trifid	18
17. Filaments long and projecting	<i>alpha</i> J. & T.
Filaments not to be detected	<i>zeta</i> J. & T.
18. Second abdominal segment with a pair of median subapical bristles	<i>howensis</i> J. & H.
Second abdominal segment without such bristles	19
19. With the normal knob in membrane anterior to claspers	<i>beta</i> J. & T.
Without such knob	<i>furcata</i> Hardy
20. With the bristle on posterior clasper placed subapically	21
With the bristle on posterior clasper placed in the median position	22
21. Posterior clasper short and broad	<i>epsilon</i> J. & T.
Posterior clasper long and slender	<i>omikron</i> J. & T.
22. Anterior appendage with a hook-shaped process	23
Anterior appendage without a hook-shaped process	24
23. Both presutural and acrostichal bristles present	<i>impatiens</i> Walk.
Only presutural acrostichals present	<i>tryoni</i> J. & T.
24. Anterior clasper gently arched forwards	25
Anterior clasper abruptly bent forwards	<i>alcicornis</i> Hardy
25. Prescutellar acrostichals strong	<i>hardyi</i> J. & T.
Prescutellar acrostichals absent, or at most very weak	? <i>fergusoni</i> J. & T.
26. Both presutural and prescutellar acrostichals present	<i>litoralis</i> J. & T.
Only presutural acrostichals present	<i>froggatti</i> Taylor

At present only about one-third of the species can be identified with any assurance from the female, although more than two-thirds have been allied by breeding, by capture *in copula* and by field observation. In cases where females have been associated with their respective males, an asterisk (*) has been placed in the following key. Further aid may be given when the species have a restricted distribution; for instance, *S. aurifrons* occurs abundantly in the south-eastern quarter of Australia, whereas *S. kohla* seems to be limited to Queensland. Similarly *S. hardyi* is not known from Queensland, so any females there that have the same recorded characters may be regarded as either the unknown females of *S. furcata* or of *S. ? fergusoni*. It seems probable that *S. tryoni* has a wider frons than that on *S. froggatti*, although this character may be obscure on bred specimens.

Very few of the females are to be recognized by superficial characters seen at a glance, but the red apex to abdomen on *securifera*, the red antennae on *bancrofti* and the quite distinct appearance of *S. litoralis*, with its very wide frons, lend themselves to ready recognition. *S. peregrina* may be readily isolated, its group of bristly hairs on the propleura being distinctive, but the mass of the species fall into two subgenera on the propleural character and may be further divided on certain bristle characters.

In 1927, J. R. Malloch (These PROCEEDINGS, lii, 334) suggested that certain unused characters, including the propleural one, might be used to ally sexes, but he overlooked the important point that the most closely allied species are generally difficult to recognize from females, and these are usually consistent in the characters he mentions. Malloch's suggestion does not seem very helpful for Australian forms, and I would suggest that characters he uses for specific recognition might be studied first for their value in group recognition. Again, Malloch's suggestion that the female genital segments might be used as specific indices apparently does not apply to Australian forms. When breeding these flies in numbers, I found that characters within the vagina may prove valuable, though not of use in practice. On freshly-emerged females, it is possible to extrude the vaginal skin and study the plates and depressions there, but I know no means of doing this once the integument becomes hardened.

Key enabling the sexes of some Australian species of Sarcophaga to be allied.

1. Genital segment red on both sexes. Propleura bare, male without, female with only prescutellar, acrostichals. Without black bristly hairs behind postoculars.
(Introduced) *securifera Vill.
- Genital segment black or brown on male, black on female 2
2. Propleura bare 3
- Propleura with hairs varying from 2-3 black bristly ones to moderately plentiful but confined to the central area. Only prescutellar acrostichals present. Two rows of black bristly hairs behind postoculars *peregrina Desv.
- Propleura hairy, the hairs light-coloured and occupying all or most of the area .. 7
3. With one or more rows of black bristly hairs behind postoculars 4
- Without black bristly hairs behind postoculars 6
4. Both presutural and prescutellar acrostichal bristles present.
 - Two rows of black bristly hairs behind postoculars *synia J. & H.
 - One row of black bristly hairs behind postoculars spinifera Hardy
 - Only prescutellar acrostichals present 5
5. With two rows of black bristly hairs behind postoculars *aurifrons Macq.; *kohla J. & H.
 - At most with only one row of black bristly hairs behind postoculars.
 - Antennae red bancrofti J. & T.
 - Antennae black *eta J. & T.
 6. Both presutural and prescutellar acrostichals present
 - *omega J. & T.; *kappa J. & T.; *depressa J. & T.; usually *gamma J. & T.
 - Only prescutellar acrostichals present .. *misera Walk.; sometimes *gamma J. & T.
 7. With two rows of black bristly hairs behind postoculars *epsilon J. & T.
 - Without black bristly hairs behind postoculars 8
 8. Both presutural and prescutellar acrostichals present 9
 - Prescutellar acrostichals absent *tryoni J. & T.; *foggatti Taylor
 9. With a pair of median discal bristles on second abdominal segment .. howensis J. & H.
 - Without median discal bristles on second abdominal segment 10
 10. Thorax with central stripe rather obscured. Head yellow only below. Frons of female unusually wide, nearly twice the width of an eye *littoralis J. & T.
 - Thorax with the central stripe normal. Frons of female normal. Head entirely yellow 11
 11. Frons deeply golden *alpha J. & T.; zeta J. & T.; *beta J. & T.; *impatiens Walker; alicornis Hardy; *omikron J. & T.
 - Frons yellow *hardyi J. & T.; ?fergusoni J. & T.; furcata Hardy

Subgenus PARASARCOPHAGA J. & T.

Originally I relied upon the presence of closely associated bristles placed subapically on the posterior clasper for the recognition of this subgenus, but apparently this character is variable for exotic species. Nevertheless, where the character does occur, it seems advisable to place the species in this subgenus and add thereto forms that appear to be obviously allied though without the character.

The Indian forms listed above under this subgenus include *ballardi* and *annandalei*, which species appear to have only one subapical bristle, whilst *ballardi*, *doleschalli* and *khasiensis* come near the *misera*-group. Another set of mutually related forms appears to be *annandalei*, *kempi* and *walayari*; and the relationship is obscure in regard to *caudagalli*, *futuris* and *ostindicae* unless the last be related to the *albiceps*-group; it is like *bambridgei* in being without an apparent bristle on the posterior clasper. Although *haemorrhoidalis* does not seem to belong to this subgenus, it is relegated there as it conforms to these bristle characters.

SARCOPHAGA MISERA group.

To the eighteen names already listed under this group, there is now added: *tsushimae* Senior-White, 1924, India.—The nature of the anterior appendage on this species shows a gradation between this group and certain species listed by me in the miscellaneous *Parasarcophaga*.

SARCOPHAGA MISERA Walker.

Sarcophaga ceylonensis Curran, Amer. Mus. Novitates, No. 375, 1929, 10 (nec Parker, 1923).

A record of this species from Victoria by Curran and his remarks suggesting the use of Parker's name for the Australian form, overlook the remarks on Parker's species published in 1927; these species are not identical specifically. Moreover, there seems to be no reason why Walker's name should not be used for the species which is not difficult to recognize from the female, and Major E. E. Austen has identified specimens by comparison with the type.

Subgenus SARCOPHAGA Meig.

There appear to be two groups in the Indo-Australian element, separable by the propleura being bare or hairy, and I am able to ascertain this character at present for the Australian species only. Those with the bare propleura, consisting of five species only, fall into relationship with the typical subgenus *Sarcophaga* as far as I am at present able to ascertain, and I have been able to ally two Australian species with exotic forms, suggesting group values.

SARCOPHAGA RUFICORNIS group (new group).

Forceps rather long and strongly bent at apex (as figured by Senior-White, not by Johnston and Hardy, whose figure was drawn from a different angle). The anterior and posterior claspers of almost equal length and the bristle on the latter placed subapically. The aedeagus has the inner process projecting beyond the sheath and the anterior appendage is short.

Two species: *ruficornis* Fabricius, 1794, India; *kappa* Johnston & Tiegs, 1921, Australia (*illingsworthi* Parker, 1922, Australia = *kappa*).

There can be no doubt concerning the alliance between these two species, for the structure of their genitalia is essentially the same. I have examined the structure on an Indian specimen having the organs exposed in the ordinary way, as well as the genitalia mounted by Senior-White.

SARCOPHAGA CRINITA group.

Hardy, Australian Zoologist, xiii, 1934, 52.

The Indian *crinita* does not have the minute indentation at the apex of the forceps; a basal flange covers the lower half of the anterior clasper, but this is not symmetrical on both sides; the clasper on one side of the aedeagus is as illustrated by Senior-White, i.e., almost furcate, but that on the other side is

normal. Owing to the nature of the mounting, I am unable to ascertain if the bristle at the base of the posterior clasper is present, but there is a subapical bristle present, this being an addition that might be fortuitous.

From Manus, an island of the Mandated Territory of New Guinea, Mr. N. E. H. Caldwell secured a specimen of this group whose genitalia conform remarkably well with the figure given for *S. kankauensis* Baranoff, from Formosa.

SARCOPHAGA BANCROFTI J. & T.

Johnston and Hardy, Proc. Linn. Soc. N.S.W., xlviii, 1923, 122.

Hitherto the characters of this species have not been made out with assurance, but now a small series of specimens with well extracted genitalia has enabled me to ascertain the true characters. The figure given by Johnston and Hardy is moderately accurate. The forceps are broad, the claspers are of about equal length, and a median bristle occurs on the posterior one. The anterior clasper is strongly curved. The apex of the sheath terminates in a slender process along which the apex of both filaments lies protected and, when in their normal position, they are not easily detected as being structures apart from the sheath. The lobe is stout and the anterior appendage small with the tip curved, but not to the extent showing in the published figures.

It will be noted that the apex of the sheath is not split, as shown in the figures, but appears to be so because of the filaments occurring there. Also, it is suggested below that the type of *S. fergusoni* may prove to be identical with this species but confused with quite a different species standing under the same name. A conspicuous feature of *S. bancrofti* lies in the antennae being red, or yellow if very pale, instead of black.

Hab.—Queensland: Goondiwindi, 5 males, October and November, 1935. One specimen has the genitalia mounted on a cellulose slip in Canada balsam, displaying the various parts of the aedeagus.

Subgenus —————.

Those species that have the propleura covered with hairs come into this section; this character has not been taken into account, so far as I have yet ascertained, under named divisions standing as genera and proposed by various authors.

SARCOPHAGA ANTILOPE group.

Hardy, Proc. Linn. Soc. N.S.W., lii, 1927, 448.

To the six names that have been listed under this group must be added: *henryi* Senior-White, 1924, India; *flavinervis* Senior-White, 1924, India; *furcata* Hardy, 1932, Australia.

The little knob anterior to the claspers is missing on *furcata*, and I did not detect it on *henryi*. The anterior clasper is very shallowly bifid on *flavinervis*, which species has also a hook-shaped process suggesting an alliance with the *impatiens*-group.

SARCOPHAGA IMPATIENS group.

Hardy, Austr. Zool., viii, 1934, 53.

To the two species placed under this group must be added: *banksi* Senior-White, 1924, Philippines.

The remarkable similarity of the genitalia of this species to those of the Australian *tryoni* suggests a close relationship, but there is no hook-shaped process on the anterior appendage and the claspers are comparatively small, the anterior

one being without the flange. Nevertheless the bristle on the posterior clasper is in conformity with the group and the general features are similar.

SARCOPHAGA ? FERGUSONI J. & T.

Johnston and Hardy, Proc. Linn. Soc. N.S.W., xlvi, 1923, 124; fig. 1 only.

The type of *S. fergusoni* may be a specimen of *S. bancrofti*, for there is much to suggest this. Other specimens standing under the name apparently belong to a different subgenus and conform in genitalia to the figure given by Johnston and Hardy to supplement the drawing of the damaged genitalia on the type. Some new specimens before me have the form of genitalia corresponding to the latter figure, but show the anterior appendage full and rather broadly developed and without the curved apex. The apex of the sheath has, in addition, a pair of laterally spreading processes not shown in the figure. Moreover, the posterior clasper is twice as long as the anterior one and not like that drawn from the type which corresponds more closely to that on *bancrofti*. It is probable that Johnston and Hardy confused two species in the inferior material before them.

Hab.—Queensland: Goondiwindi, 2 males, November, 1935.

SARCOPHAGA OMIKRON J. & T.

Johnston and Hardy, Proc. Linn. Soc. N.S.W., xlvi, 1923, 120.

Most specimens hitherto collected are in inferior condition, but the present series shows the posterior clasper to be longer than the anterior, slender, well curved and with a subapical bristle.

Hab.—Queensland: Goondiwindi, October and November, 1935; 3 ♂, 4 ♀.

Genus BLAESOXIPHA Loew.

Blaesoxipha Loew, Wien. Ent. Monatsch., v, 1861, 384.—*Locustivora* Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiv, 1923, 187.

During the plagues of grasshoppers in the years 1934–1935, Mr. J. A. Weddell bred a parasite that is presumably identical with that described by Skuse, as the host is the same. This form, *Masicera pachytyli* Skuse, which Coquillett placed as a *Sarcophaga*, is apparently in no way generically distinct from other grasshopper parasites recorded under the generic name *Blaesoxipha*, and corresponds very well in its generic characters with those given by Lundbeck in his *Diptera Danica*. The two species known to me as occurring in Australia have most of their characters in common, but differ slightly in their genitalia. I have been unable to ally either of these with exotic species which have been adequately described during recent years, so they are probably indigenous forms and not introduced ones.

The following characters, unless otherwise stated, apply to both species.

Head: Only the inner vertical bristles present; ten frontals, the vibrissa and three facials, a second row of weak facials and a row of three bristles near the eye, nine orals. The postoculars have, below them, black bristly hairs that tend to form two further rows. One strong postvertical pair and a paired row of four further bristles extend behind the ocellar tubercle. *Thorax:* three humeral bristles, two posthumeral, four notopleural, two being very much reduced, one presutural, two supraalar, three intraalar, one being weak, one postalar, three presutural and three postsutural dorsocentrals, a paired row of acrostichals complete, the anterior pair and the posterior pair being well developed and the intermediate ones may also be more or less conspicuously developed but some-

what variable in this respect. Four pairs of scutellar bristles are strongly developed. Except for two large bristles above the coxae and the adjacent bristly hairs, the propleural region is bare. The mesopleural row is well developed and, in addition, further bristles may develop along the upper margin. A row of three sternopleurals and the pteropleural and hypopleural bristles are all normal. *Abdomen*: On the first segment laterally, there are three submarginals and about four discals arranged in two rows. The following segments each have a median pair of subapicals and laterally about five submarginals. *Legs*: the femora have the system of bristles conforming to that of *Sarcophaga*, but the hairs are invariably short. *Wings*: as in *Sarcophaga*, including the bristles on the vein R_{4-5} . *Terminalia*: the forceps taper more or less uniformly to the apex and are contiguous to the apex, i.e., they do not diverge apically as in *Sarcophaga*, but lie adjacent for their whole length. The forceps are without hairs, but bristles occur on a limited area giving a roughened appearance there. No bristle has been detected on the claspers, which are curved but otherwise simple. The anterior clasper is somewhat strongly curved and much broadened out on one species. The aedeagus has the two hinged segments as in *Sarcophaga*, but the apical one is much reduced and consists of a shaft, at the apex of which two small processes occur anteriorly, and then comes the sheath, simple in outline and partly enveloping the anterior appendage, which is also simple in outline and consists of a paired curved tapering part, blunt at the apex. The sheath and the anterior appendage lie closely adjacent to each other, and on one species the outline of the sheath is distended by the formation of flattened lobes, one at the apex slightly bent rearwards and one at each side tending still further to hide the anterior appendage.

Key to species of Blaesoxipha.

Anterior clasper about twice as broad at apex as at its narrowest part. Sheath of aedeagus with three rather small but well developed lobes, one at the apex and two at the sides *pachytyli* Skuse
 Anterior clasper hardly broadened at apex. Sheath of aedeagus with lobes hardly if at all discernible sp.

BLAESOXIPHA PACHYTYLI Skuse.

Masicera pachytyli Skuse, Agric. Gaz. N. S. Wales, 1891, 251.—*Sarcophaga pachytyli* Coquillet, Insect Life, v, 1892, 22.—*Locustivora pachytyli* Johnston & Tiegs, Proc. Roy. Soc. Queensland, xxxiv, 1923, 187.

Hab.—New South Wales, Queensland, and probably widely distributed over other mainland States.

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Postscript, added 23rd May, 1936.—In a letter Dr. Boris Rohdendorf has kindly given me notes that tend to show where the above species come within his scheme of classification. There are two notes intimately connected with the above paper:

"The species *antilope* Bott. and other closely allied species must be referred to the genus *Chrysosarcophaga* Towns. 1932, type *superba* Towns. 1932, Solomon Isl., vide Baranov, 1934 . . ."

"The species *aspinata* S.W. is a *Blaesoxipha*."